Clinical Benefit of Hospitalization for Older Adults With Unexplained Syncope: A Propensity-Matched Analysis

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Study objective: Many adults with syncope are hospitalized solely for observation and testing. We seek to determine whether hospitalization versus outpatient management for older adults with unexplained syncope is associated with a reduction in postdisposition serious adverse events at 30 days.

Methods: We performed a propensity score analysis using data from a prospective, observational study of older adults with unexplained syncope or near syncope who presented to 11 emergency departments (EDs) in the United States. We enrolled adults (≥60 years) who presented with syncope or near syncope. We excluded patients with a serious diagnosis identified in the ED. Clinical and laboratory data were collected on all patients. The primary outcome was rate of post-ED serious adverse events at 30 days.

Results: We enrolled 2,492 older adults with syncope and no serious ED diagnosis from April 2013 to September 2016. Mean age was 73 years (SD 8.9 years), and 51% were women. The incidence of serious adverse events within 30 days after the index visit was 7.4% for hospitalized patients and 3.19% for discharged patients, representing an unadjusted difference of 4.2% (95% confidence interval 2.38% to 6.02%). After propensity score matching on risk of hospitalization, there was no statistically significant difference in serious adverse events at 30 days between the hospitalized group (4.89%) and the discharged group (2.82%) (risk difference 2.07%; 95% confidence interval −0.24% to 4.38%).

Conclusion: In our propensity-matched sample of older adults with unexplained syncope, for those with clinical characteristics similar to that of the discharged cohort, hospitalization was not associated with improvement in 30-day serious adverse event rates. [Ann Emerg Med. 2019;74:260-269.]

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INTRODUCTION

Background

There are greater than 1 million emergency department (ED) visits for syncope (transient loss of consciousness) in the United States every year,[1] resulting in $2.4 billion in annual hospital costs.[2] The wide range of potential causes, some benign and others life threatening, make the clinical management of this entity challenging.[3]

Importance

Despite substantial research efforts to develop and validate accurate risk-stratification tools,[4-10] there remains considerable uncertainty in regard to which patients with syncope can be safely discharged from the ED.[11] Greater than 30% of these visits result in hospitalization; for older adults (≥60 years), this proportion is greater than 50%.[12] Although some of these hospitalizations are for specific therapeutic reasons (eg, pacemaker insertion, anticoagulation for pulmonary embolism), older adults with unexplained syncope are often admitted to inpatient or observation units solely for observation or further testing.[13-15] Such hospitalizations for syncope patients without a serious diagnosis identified in the ED are costly and may be of little to no clinical benefit.[2,16-18]

Goals of This Investigation

To our knowledge, there are no data demonstrating the benefit of hospital-based evaluation for patients with

Editor's Capsule Summary

What is already known on this topic

Syncope accounts for greater than 1 million US emergency department (ED) visits annually. For older adults with syncope, admission rates exceed 50%.

What question this study addressed

Using prospective data from 2,492 patients aged 60 years and older who presented with syncope and for whom no serious diagnosis was identified in the ED, this study compares rates of 30-day serious adverse events for those who were hospitalized versus those who were discharged from the ED.

What this study adds to our knowledge

Among propensity score–matched patients, rates of serious adverse events for hospitalized and discharged patients were similar.

How this is relevant to clinical practice

This does not directly change practice but suggests that we may be able to safely discharge more syncope patients.

syncope and an unremarkable ED evaluation result.[11] Using propensity score matching, we sought to determine whether hospitalization versus outpatient management for older adults with unexplained syncope was associated with a reduction in post-ED serious adverse events at 30 days.

MATERIALS AND METHODS

Study Design and Setting

We performed a secondary analysis of data from a multicenter, prospective, observational study of older adults who presented to an ED with syncope or near syncope. The institutional review boards at all enrolling sites approved the study and we obtained written, informed consent from all participating subjects or their representatives. The study was conducted at 11 academic EDs, all located in nonprofit hospitals, across the United States (Table E1, available online at http://www.annemergmed.com) from April 28, 2013, to September 21, 2016. Ten of the 11 EDs were teaching hospitals with a trauma center; ED volume ranged from 47,000 to 120,000 visits per year.

Selection of Participants

Patient inclusion criteria for eligibility were aged 60 years or older and a complaint of syncope or near syncope. We defined syncope as transient loss of consciousness associated with postural loss of tone, with immediate, spontaneous, and complete recovery. We defined near syncope as the sensation of impending loss of consciousness without actual loss of consciousness. We excluded candidates if their symptoms were thought to be due to intoxication, seizure, stroke, head trauma, or hypoglycemia. Additional exclusion criteria were the need for medical intervention to restore consciousness (eg, defibrillation), new or worsening confusion, and inability to obtain informed consent from the patient or a legally authorized representative.

For this analysis, we also excluded all patients who had a serious diagnosis identified in the ED: death, significant cardiac arrhythmia, myocardial infarction, significant structural heart disease, stroke, pulmonary embolism, aortic dissection, hemorrhage or anemia requiring blood transfusion, acute pulmonary edema, pneumonia, sepsis, acute renal failure, intracranial bleeding, or acute surgical illness (Table E2, available online at http://www.annemergmed.com). We identified serious diagnoses in 1 of 2 ways: directly by the treating physician during the ED visit, using a prespecified list of serious diagnoses presented in the data collection form; or by ED chart review by trained research assistants who were blinded to the results of the 30-day follow-up telephone call. We used both methods to ensure that the final study cohort consisted of only patients who truly had no serious diagnosis identified in the ED.

Methods of Measurement

All patients underwent standardized history, physical examination, cardiac biomarker, and 12-lead ECG testing. Trained research assistants directly questioned patients about symptoms associated with the syncopal or near-syncopal episode. They prospectively collected data on patients' medical history, medications, and physical examination findings from treating providers. No standardized clinical protocols were implemented as part of our study; in other words, clinical management, other than ECG and biomarker testing, was left to the discretion of the ED and inpatient providers.

Research staff obtained blood samples for testing at a core laboratory (University of Rochester, Rochester, NY). Laboratory staff performed 2 assays with the Roche Elecsys platform: N-terminal pro-brain natriuretic peptide and the fifth-generation high-sensitivity cardiac troponin T. We classified N-terminal pro-brain natriuretic peptide as abnormal above a cutoff of 125 pg/mL. We classified high-sensitivity cardiac troponin T as abnormal above the 99th

percentile for a reference population (19 ng/L). Although high-sensitivity cardiac troponin T had not been approved by the Food and Drug Administration at the study, we anticipated that this assay would receive approval and be integrated into future standard of care (the administration granted approval in January 2017). Core laboratory results for N-terminal pro-brain natriuretic peptide and high-sensitivity cardiac troponin T were unavailable at the ED evaluation; however, the ED providers were free to order local pro-brain natriuretic peptide and conventional troponin testing. The disposition of the patients (admission versus observation versus direct discharge) was at the discretion of the treating providers.

The post-ED disposition of the patient was prospectively collected by research assistants and confirmed by electronic medical record review. The disposition was classified as one of the following: admitted to an inpatient service, sent to observation, transferred to an outside hospital, and discharged from the ED. We classified all patients who were admitted, observed, or transferred as "hospitalized."

Outcome Measures

Our primary outcome was the rate of serious adverse events identified after ED disposition within 30 days of the index ED visit (including serious events occurring both during the index hospitalization and after discharge). These included death from any cause, significant cardiac arrhythmia, myocardial infarction, new diagnosis of structural heart disease, stroke, pulmonary embolism, aortic dissection, subarachnoid hemorrhage, cardiopulmonary resuscitation, internal hemorrhage or anemia requiring transfusion, recurrent syncope or fall resulting in major traumatic injury, or cardiac intervention. Significant cardiac arrhythmias included ventricular fibrillation, ventricular tachycardia, sick sinus disease, Mobitz II atrioventricular heart block, complete heart block, symptomatic supraventricular tachycardia, symptomatic bradycardia, and pacemaker malfunction. These outcomes are consistent with standardized research reporting and clinical management guidelines.[11,19]

The occurrence of a serious adverse event was determined with data collected through a review of the electronic medical records conducted by research personnel at each study site, as well as telephone calls (performed by the central site) to enrolled patients at 30 days to identify out-of-hospital deaths, ED visits, and hospitalizations that occurred outside the study sites. Local research personnel performing chart review were blinded to the results of the telephone follow-up. If a patient or his or her authorized representative reported an ED or hospital visit that occurred outside of the study site, then we obtained and reviewed the medical charts associated with those visits. For patients research staff were unable to contact at 30 days, we queried the Social Security Death Index Master File in May 2018.

Primary Data Analysis

We calculated descriptive statistics for the baseline characteristics of the patient cohort, stratified by disposition, before and after propensity score matching. We used χ^2 tests or t tests to test associations between the categoric or continuous variables and ED disposition. To account for possible confounding variables for disposition, we used a propensity score analysis, using greedy nearest neighbor matching, to evaluate the association between hospitalization and risk of serious adverse events.[20] This approach balanced measured patient characteristics between patients who were discharged and those who were hospitalized at the cost of a reduced sample size. At each matching step, we chose the hospitalized subject who had not yet been matched but was closest to the discharged subject. Because this was a secondary analysis of data collected with the primary aim of deriving a syncope risk-stratification tool, the sample size and power calculations were driven by this primary analysis.

We estimated the propensity scores for each individual, using a logistic regression model in which the outcome was whether the patient was discharged or not. We used 43 prospectively collected covariates to predict whether patients were discharged: age, sex, race, dyspnea, chest discomfort, hypotension, abnormal ECG result, emergency physician risk assessment, N-terminal pro-brain natriuretic peptide values, high-sensitivity cardiac troponin T values, physical examination findings, medications, whether patients had a history of baseline cognitive impairment or dementia, premature (<50 years) sudden death of siblings or parents, history of stroke, heart failure, ejection fraction less than 40%, peripheral vascular disease, implanted permanent pacemaker/defibrillator, coronary artery disease, structural heart disease, arrhythmia, seizure disorder, diabetes requiring medication, hypertension, chronic renal insufficiency, or cancer requiring current active treatment (Table E3, available online at http://www.annemergmed.com). We determined physician risk assessment through the treating attending emergency physician's estimate of the "probability that the patient will experience 30-day cardiac death or serious cardiac event." We matched each patient in the discharged group with an individual in the hospitalized group with the closest propensity score, resulting in pairs of observations that had similar propensity scores; the pairing

was not used in further analysis. We compared the risk of 30-day post-ED disposition serious adverse events, as well as mortality alone, after the index visit in discharged and hospitalized patients, before and after propensity score matching.

As a sensitivity analysis, we used a Poisson regression model to compare the rates of 30-day post-ED serious adverse events (including mortality), as well as mortality alone, in both groups. The Poisson regression took into account the amount of time that patients were at risk for serious adverse events (ie, hospitalized patients had fewer postdischarge days out of the hospital at 30 days). One hundred one patients with missing length-of-stay data were excluded from the analysis. For patients who had a serious adverse event, time at risk was the number of days until the serious adverse event since ED disposition.

As an additional sensitivity analysis, we repeated the above analyses with a more restricted primary outcome; in other words, serious adverse events that occurred after the ED evaluation *excluding* those that occurred during the index hospitalization, also after propensity score matching. This sensitivity analysis was performed because our initial primary outcome, which included events that occurred during the index hospitalization, may have biased against the hospitalized cohort by increasing the number of adverse events detected in hospitalized patients. Mitigating such a detection bias is important because inhospital monitoring may be more likely to detect certain conditions (eg, cardiac arrhythmias). In the sensitivity analysis using a Poisson regression and this more restricted primary outcome, for discharged patients who did not have a serious adverse event, time at risk was the number of days since discharge at 30 days. For hospitalized patients, it was 30 days minus days in the hospital. Statistical analyses were performed in R (version 3.5.0; R Foundation for Statistical Computing, Vienna, Austria).[21]

RESULTS

Characteristics of Study Subjects

Of 6,930 eligible patients who presented during the 3.5-year study period, 3,686 consented for enrollment. Of those patients, 105 were withdrawn or lost to follow-up, leaving 3,581 in the base cohort (Figure). A total of 1,054 patients (29.4%) had serious diagnoses identified in the ED and were excluded from further analysis. Some patients were not enrolled because the ED provider did not have sufficient time to cooperate with the research assistant ("provider request"); others were excluded if the site principal investigator reviewed the chart and identified the presence of an exclusion criterion (eg, a diagnosis of seizure) that was not initially detected by the research assistant in the ED ("principal investigator withdrawal"). A list of these diagnoses and their frequencies are provided in Table E2 (available online at http://www.annemergmed.com). Our final study cohort consisted of 2,492 older adults with a mean age of 72.6 years (SD 8.9 years), and 50.8% were women. The majority of patients in the study cohort (n=2,482; 99.6%) were successfully reached by telephone, with the remainder (n=10) requiring chart review, death index query, or both. Table 1 describes the baseline characteristics of the study cohort before and after propensity score matching. Before matching, hospitalized patents were significantly older, had a greater prevalence of heart disease, and a greater rate of elevated cardiac biomarker levels than the discharged patients. These and other baseline characteristics were balanced after matching.

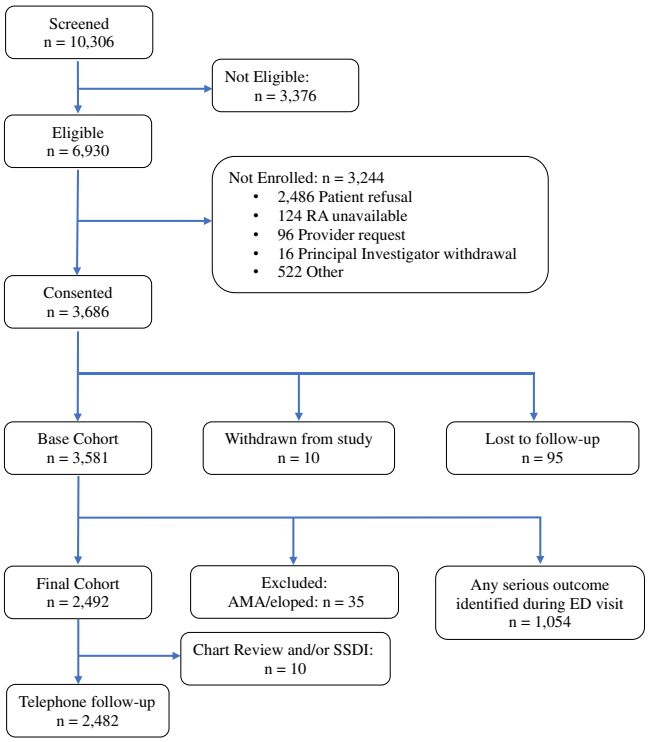

Figure. Study flow chart. *RA*, Research assistant; *AMA*, against medical advice; *SSDI*, Social Security Death Index.

Main Results

Of the 2,492 patients in our final cohort, 1,866 (74.9%) were hospitalized. Of those hospitalized, the majority of patients, 1,129 (60.5% of 1,866), were observed, 732 (39.2%) were admitted to the hospital, and 5 (0.3%) were transferred. The mean length of stay for the hospitalized

Table 1. Baseline characteristics of syncope patients by disposition.

	No. (%)					
	Before Propensity Score Matching			After Propensity Score Matching		
Characteristic	**Hospitalized (n=1,866)**	**Discharged (n=626)**	**Standardized Differences**	**Hospitalized (n=532)**	**Discharged (n=532)**	**Standardized Differences**
Demographics						
Age, mean (SD), y	73.1 (8.9)	71.1 (8.9)	22.1	70.6 (8.6)	71.4 (8.9)	9.2
Age, y			22.8			12.0
60–<70	790 (42.3)	323 (51.6)		289 (54.3)	268 (50.4)	
70–<80	593 (31.8)	185 (29.6)		158 (29.7)	161 (30.3)	
80–<90	408 (21.9)	90 (14.4)		58 (10.9)	78 (14.7)	
≥90	75 (4.0)	28 (4.5)		27 (5.1)	25 (4.7)	
Sex			10.8			1.1
Women	922 (49.4)	343 (54.8)		276 (51.9)	279 (52.4)	
Men	944 (50.6)	283 (45.2)		256 (48.1)	253 (47.6)	
Race			2.4			1.1
White	1,541 (83.0)	513 (82.9)		453 (85.2)	447 (84.0)	
Black	259 (13.9)	84 (13.6)		66 (12.4)	66 (12.4)	
Asian	24 (1.3)	7 (1.1)		7 (1.3)	7 (1.3)	
Other	33 (1.8)	15 (2.4)		6 (1.1)	12 (2.3)	
History						
Congestive heart failure	219 (11.7)	35 (5.6)	22.0	29 (5.5)	31 (5.8)	1.6
Coronary artery disease	535 (28.7)	111 (17.7)	26.2	102 (19.2)	99 (18.6)	1.4
Arrhythmia	355 (19.0)	101 (16.1)	7.7	86 (16.2)	90 (16.9)	2.0
Any of CHF, CAD, or arrhythmia	812 (43.5)	183 (29.2)	30.0	170 (32.0)	162 (30.5)	3.3
Dyspnea	353 (18.9)	112 (18.2)	2.7	83 (15.6)	86 (16.2)	1.5
Chest discomfort	160 (8.6)	37 (5.9)	10.3	33 (6.2)	31 (5.8)	1.6
Hypotension	166 (8.9)	32 (5.1)	14.9	29 (5.5)	30 (5.6)	0.8
Abnormal ECG	979 (53.0)	280 (46.1)	13.8	214 (40.2)	245 (46.1)	11.8
Pulse rate, beats/min			2.4			1.1
<60	250 (13.5)	85 (13.8)		74 (13.9)	75 (14.1)	
60–100	1,492 (80.6)	498 (80.8)		433 (81.4)	431 (81.0)	
>100	109 (5.9)	33 (5.4)		25 (4.7)	26 (4.9)	
Physician risk assessment, mean (SD)	8.7 (11.5)	4.2 (7.8)	45.8	4.9 (7.3)	4.3 (8.0)	8.0
Cardiac biomarkers						
NT-proBNP						
BNP >125 pg/mL	1,128 (63.5)	305 (51.5)	24.4	260 (48.9)	277 (52.1)	6.4
BNP, mean (SD)	796.5 (2,323.3)	602.0 (2,709.1)	7.6	659.2 (2,443.3)	639.4 (2,849.9)	0.8
Hs troponin T						
Troponin >19 ng/L	476 (27.5)	104 (18.2)	22.4	98 (18.4)	100 (18.8)	1.0
Troponin, mean (SD)	21.3 (60.1)	14.8 (26.6)	14.0	17.0 (38.2)	15.1 (27.4)	5.7

CHF, Congestive heart failure; *CAD*, coronary artery disease; *NT-proBNP*, N-terminal pro-brain natriuretic peptide; *BNP*, pro-brain natriuretic peptide; *Hs*, high-sensitivity.

cohort was 53.9 hours (SD 75.5) compared with 5.5 hours (SD 3.6) for the discharged patients. Overall, 158 patients (6.34%; 95% confidence interval [CI] 5.38% to 7.30%) had a serious adverse event within 30 days, including 17 (0.68%; 95% CI 0.36% to 1.01%) who died. Of the patients who were lost to follow-up, 7 were found to have died within 30 days according to query of the Social Security Death Index. The mean length of time elapsed

before detection of any serious adverse event was 7.5 days in the hospitalized cohort and 13.8 days in the discharged cohort.

Table 2 describes the frequency of each serious adverse event by disposition. The most common serious outcome was serious cardiac arrhythmia (n=58/158; 36.7%), of which symptomatic supraventricular tachycardia was the most frequent (n=22/158; 13.9%). In the unadjusted analysis, the risk of postdischarge serious events at 30 days was higher among hospitalized patients (n=138/1,866; 7.4%; 95% CI 6.21% to 8.58%) compared with discharged patients (n=20/626; 3.19%; 95% CI 1.82% to 4.57%), representing an unadjusted risk difference of –4.2% (95% CI –2.38% to –6.02%).

Propensity score matching resulted in a sample size of 1,064, with 532 patients each in the discharged and hospitalized groups. Table E3 (available online at http://www.annemergmed.com) describes the propensity score model for predicting patient discharge. All covariates were balanced in the 2 cohorts after matching (Table 1), with overlapping propensity score distributions after matching (Figure E1, available online at http://www.annemergmed.com). After propensity score matching, there was no significant difference in the risk of post-ED serious adverse events at 30 days between the hospitalized cohorts (4.89%; 95% CI 3.06% to 6.72%) and discharged cohorts (2.82%; 95% CI 1.41% to 4.23%) (risk difference 2.07%; 95% CI −0.24% to 4.38%) (Table 3). Our sensitivity analysis using a Poisson regression model after propensity score matching gave similar results. The rate of post-ED adverse events per 30 days was 2.86% (95% CI 1.73% to 4.75%) in the directly discharged group and 5.1% (95% CI 3.47% to 7.49%) in the hospitalized group (rate ratio 0.56; 95% CI 0.30 to 1.06). Our analysis using risk of 30-day mortality post-ED visit produced similar results; in other words, there was no statistically significant mortality difference between the hospitalized cohort (0.75%; 95% CI 0.21% to 1.91%) and discharged cohort (0.56%; 95% CI 0.12% to 1.64%) (risk difference 0.19%; 95% CI –1.16% to 0.78%). Our Poisson regression model using the propensity score–matched cohorts to compare 30-day mortality rates gave similar results (Table 3). Our sensitivity analysis using a more restricted primary outcome, which excluded serious adverse events occurring during the index hospitalization to account for detection bias, returned similar results (ie, we found no significant difference in mortality or serious adverse events at 30 days, using both risk difference and Poisson regression) (Table E4, available online at http://www.annemergmed.com).

LIMITATIONS

Our study is subject to certain limitations. Because of its observational nature, unmeasured confounders may be a source of bias. We attempted to mitigate this limitation by using propensity score matching and by including an overall physician risk estimation of adverse cardiac outcomes at 30 days prospectively collected at enrollment. Because this was an observational study, standardized protocols were not used to guide the clinical care that patients received in the ED or in the hospital, and thus variation across sites may have occurred. Because we enrolled only patients aged 60 years or older, our findings may not necessarily be valid in younger syncope patients. However, it is patients in this age category who are most often admitted for observation or further testing, and thus that age range is associated with the greatest resource use. Because 47% of eligible patients declined to participate, sampling bias may have occurred. Our sample size was limited by the size of the data set that was collected for the primary analysis, and thus the possibility of a type II error remains. Our propensity score matching was able to match only 532 of the 1,886 hospitalized patients, which further reduced our sample size and statistical power. Nonetheless, to our knowledge this is the largest prospectively collected cohort of US syncope patients to date. Although our follow-up rate at 30 days was generally high, it is possible that certain patients who were lost to follow-up (n=95) experienced serious adverse events. We mitigated this limitation by querying the Social Security Death Index.

DISCUSSION

Our results, using propensity score matching, suggest that among older adults who present with syncope or near syncope and who receive no serious diagnosis in the ED, hospitalization is not associated with a significant reduction in serious adverse events at 30 days. These findings were consistent across our sensitivity analyses using a Poisson regression model and using a narrower primary outcome that excluded inhospital adverse events, both of which demonstrated no difference in adverse events or mortality at 30 days. We conducted 2 differing analyses, 1 including inhospital serious events in our primary outcome and 1 excluding them. This was done to mitigate the potential detection bias that could have increased the number of serious events found in the hospitalized group simply by virtue of these patients' being monitored more closely in the hospital than they would have been as outpatients. Our secondary analysis, excluding the inhospital serious events, has the potential to bias our results toward the null hypothesis by censoring the initial high-risk period

Table 2. Adverse events identified after ED stay, stratified by disposition.

Adverse Event*	Overall Cohort (n=2,492), No. (%)	Hospitalized (n=1,866), No. (%)	Admitted† (n=732), No. (%)	Observed (n=1,129), No. (%)	Hospitalized: Identified During Index Hospital Visit, No. (%)	Hospitalized: Identified After Index Hospital Visit, No. (%)	Discharged (n=626), No. (%)	% Difference‡ (95% CI)
Any 30-day serious event	158 (6.3)	138 (7.4)	79 (10.8)	59 (5.2)	98 (5.3)	46 (2.5)	20 (3.2)	4.2 (2.4 to 6.0)
30-day death	17 (0.7)	14 (0.8)	10 (1.4)	4 (0.4)	1 (0.1)	13 (0.7)	3 (0.5)	0.3 (−0.4 to 0.9)
Serious cardiac arrhythmias								
Any cardiac arrhythmia	58 (2.3)	54 (2.9)	31 (4.2)	23 (2.0)	44 (2.4)	14 (0.8)	4 (0.6)	2.3 (1.3 to 3.2)
Ventricular fibrillation	3 (0.1)	3 (0.2)	2 (0.3)	1 (0.1)	2 (0.1)	1 (0.1)	0	0.2 (0.0 to 0.3)
Ventricular tachycardia (>30 s)	6 (0.2)	6 (0.3)	2 (0.3)	4 (0.4)	6 (0.3)	1 (0.1)	0	0.3 (0.1 to 0.6)
Symptomatic ventricular tachycardia (<30 s)	1	0	0	0	0	0	1 (0.2)	−0.2 (−0.5 to 0.2)
Sick sinus disease with alternating sinus bradycardia and tachycardia	10 (0.4)	10 (0.5)	6 (0.8)	4 (0.4)	8 (0.4)	2 (0.1)	0	0.5 (0.2 to 0.9)
Sinus pause >3 s	2 (0.1)	2 (0.1)	1 (0.1)	1 (0.1)	2 (0.1)	0	0	0.1 (0.0 to 0.3)
Mobitz II atrioventricular heart block	4 (0.2)	4 (0.2)	4 (0.5)	0	3 (0.2)	2 (0.1)	0	0.2 (0.0 to 0.4)
Complete heart block	2 (0.1)	2 (0.1)	2 (0.3)	0	2 (0.1)	0	0	0.1 (0.0 to 0.3)
Symptomatic supraventricular tachycardia	22 (0.9)	21 (1.1)	10 (1.4)	11 (1.0)	16 (0.9)	6 (0.3)	1 (0.2)	1.0 (0.4 to 1.5)
Symptomatic bradycardia	8 (0.3)	6 (0.3)	4 (0.5)	2 (0.2)	5 (0.3)	2 (0.1)	2 (0.3)	0.0 (−0.5 to 0.5)
Pacemaker or ICD malfunction with cardiac pauses	0	0	0	0	0	0	0	0.0 (0.0 to 0.0)
Cardiac intervention								
Any cardiac intervention	49 (2.0)	44 (2.4)	25 (3.4)	19 (1.7)	36 (1.9)	14 (0.8)	5 (0.8)	1.6 (0.6 to 2.5)
Pacemaker	23 (0.9)	22 (1.2)	14 (1.9)	8 (0.7)	17 (0.9)	7 (0.4)	1 (0.2)	1.0 (0.4 to 1.6)
AICD	6 (0.2)	6 (0.3)	2 (0.3)	4 (0.4)	5 (0.3)	3 (0.2)	0	0.3 (0.1 to 0.6)
CABG	5 (0.2)	3 (0.2)	1 (0.1)	2 (0.2)	3 (0.2)	0	2 (0.3)	−0.2 (−0.6 to 0.3)
PTCA	8 (0.3)	7 (0.4)	5 (0.7)	2 (0.2)	5 (0.3)	2 (0.1)	1 (0.2)	0.2 (−0.2 to 0.6)
Other	7 (0.3)	6 (0.3)	3 (0.4)	3 (0.3)	6 (0.3)	2 (0.1)	1 (0.2)	0.2 (−0.2 to 0.6)
Other serious outcomes								
Myocardial infarction	11 (0.4)	10 (0.5)	5 (0.7)	5 (0.4)	8 (0.4)	4 (0.2)	1 (0.2)	0.4 (−0.1 to 0.8)
New diagnosis of structural heart disease	20 (0.8)	19 (1.0)	7 (1.0)	12 (1.1)	17 (0.9)	3 (0.2)	1 (0.2)	0.9 (0.3 to 1.4)
Stroke	12 (0.5)	9 (0.5)	6 (0.8)	3 (0.3)	5 (0.3)	4 (0.2)	3 (0.5)	0.0 (−0.6 to 0.6)
Pulmonary embolism	5 (0.2)	4 (0.2)	2 (0.3)	2 (0.2)	4 (0.2)	0	1 (0.2)	0.1 (−0.3 to 0.4)
Aortic dissection	0	0	0	0	0	0	0	0.0 (0.0 to 0.0)
Subarachnoid hemorrhage	0	0	0	0	0	0	0	0.0 (0.0 to 0.0)
Cardiopulmonary resuscitation	3 (0.1)	3 (0.2)	1 (0.1)	2 (0.2)	1 (0.1)	2 (0.1)	0	0.2 (0.0 to 0.3)
Internal hemorrhage/anemia	25 (1.0)	22 (1.2)	18 (2.5)	4 (0.4)	17 (0.9)	6 (0.3)	3 (0.5)	0.7 (0.0 to 1.4)
Recurrent syncope/fall resulting in major injury	7 (0.3)	4 (0.2)	1 (0.1)	3 (0.3)	0	4 (0.2)	3 (0.5)	−0.3 (−0.8 to 0.3)

ICD, Implantable cardioverter-defibrillator; *AICD*, automated implantable cardioverter-defibrillator; *CABG*, coronary artery bypass graft; *PTCA*, percutaneous transluminal coronary angioplasty.

*Includes patients with a history of such events, with the exception of structural heart disease.

†Includes transferred patients.

‡Difference and 95% CI for comparing occurrence of events between hospitalized and discharged patients.

Table 3. Post-ED* serious adverse events at 30 days before and after propensity score matching.

	No. (%)					
	Before Propensity Score Matching			After Propensity Score Matching		
Outcome	Hospitalized (n=1,866)	Discharged (n=626)	Risk Difference† (95% CI)	Hospitalized (n=532)	Discharged (n=532)	Risk Difference† (95% CI)
30-day serious adverse events	138 (7.40)	20 (3.19)	4.20 (2.38 to 6.02)	26 (4.89)	15 (2.82)	2.07 (−0.24 to 4.38)
30-day all-cause mortality	14 (0.75)	3 (0.48)	−0.27 (−0.94 to 0.40)	4 (0.75)	3 (0.56)	0.19 (−0.78 to 1.16)
Poisson regression						
Outcome	**%**	**%**	**Rate Ratio‡ (95% CI)**	**%**	**%**	**Rate Ratio‡ (95% CI)**
Events per 30 days	7.86	3.25	0.41 (0.26 to 0.66)	5.10	2.86	0.56 (0.30 to 1.06)
30-day mortality rate	0.75	0.48	0.64 (0.18 to 2.22)	0.76	0.57	0.75 (0.17 to 3.34)

*Post-ED events include those that occurred during the index hospitalization.
†Risk difference was defined as percentage of risk for hospitalized patients minus percentage of risk for discharged patients.
‡Rate ratios comparing discharged with hospitalized rates are presented for Poisson regression instead of risk difference.

post-ED visit. Although neither of these analyses is perfect, both provide useful complementary information. Overall, these findings challenge the current clinical care paradigm of frequent hospitalization for older adults for unexplained syncope or near syncope solely for the purpose of additional monitoring or testing beyond that conducted in the ED.

Previous studies have demonstrated the wide variability in admission rates across hospitals for syncope in North America, ranging from 12% to greater than 80%.[8,22] Multiple studies have questioned the diagnostic yield of admission for syncope, demonstrating a lack of identifiable cause in greater than one third of admissions.[1,17,23] Given the substantial costs and potential iatrogenic harms associated with hospitalization,[2,18] efforts to promote outpatient management may improve the value and safety of syncope care.[24] Although there was a nonsignificant trend toward reduction in postdischarge serious adverse events in the hospitalized group (1.5%), given the substantial costs (>$2.4 billion annually) associated with hospitalization,[2] this may constitute low-value care.[25] Median hospital charges for syncope admission are increasing,[26] and costs for syncope patients are positively correlated with increased length of stay.[27]

Our results failed to show a significant clinical benefit of hospitalization for ED patients with unexplained syncope who were matched to similar patients in the discharged cohort. This finding suggests that among older adults with unexplained syncope who are not otherwise deemed to be at high risk, hospitalization should not be the default pathway. Rather, a frank discussion of the reasonable disposition options and their corresponding risks and benefits should be had, an approach known as shared decisionmaking.[28] Alternative clinical pathways using ambulatory cardiac monitors[29,30] or specialized outpatient syncope units[31] could represent a less disruptive, more patient-centered, and more cost-effective approach to managing unexplained syncope after initial ED evaluation.

One possible interpretation of these findings is that if a serious diagnosis is not found during the initial ED evaluation and the patient is not considered to be at high risk according to clinical variables, then the diagnostic benefit of an additional 24 to 48 hours of inpatient monitoring is likely to be very limited. The mean elapsed time before occurrence of a serious outcome was greater than 48 hours in both the hospitalized and discharged cohorts. The most common cardiac arrhythmia in the hospitalized group was symptomatic supraventricular tachycardia, which typically does not pose a serious risk to patients even if subject to delayed diagnosis. In contrast, more malignant arrhythmias, such as ventricular tachycardia or fibrillation and second-degree heart block, were rarely diagnosed postdischarge, even in the hospitalized group (Table 2).

Our unadjusted results, demonstrating a greater rate of serious adverse events in the hospitalized cohort, suggest that clinicians are adept at identifying and appropriately hospitalizing certain higher-risk patients with syncope. However, it seems that a significant proportion of those hospitalized patients may actually be appropriate for outpatient management, as demonstrated by the low rate of adverse events in our matched sample.

Previous research aimed at increasing the value of syncope care has focused on the use of observation pathways,[14,32] including 2 randomized controlled trials of

observation syncope protocols.[33,34] These studies have demonstrated the safety and value of such an approach. However, to our knowledge no previous studies have compared hospitalization versus direct discharge in ED syncope patients with a negative initial evaluation result. The 2017 American Heart Association/American College of Cardiology/Heart Rhythm Society syncope guidelines[11] state that it "may be reasonable to manage selected patients with suspected cardiac syncope in the outpatient setting in the absence of serious medical conditions," but that "hospital-based evaluation of syncope of unclear cause…has not demonstrated an improvement in patient-relevant outcomes." Our study attempted to address this very question and, using propensity score matching, found no improvement in 30-day adverse event rates. To definitively answer this question, research in the form of a well-designed, multicenter, randomized trial comparing inpatient versus outpatient management for this cohort of patients would need to be performed.

In summary, in our propensity-matched sample of older adults with syncope or near syncope and no serious diagnosis found on ED evaluation, and with clinical characteristics similar to those of the discharged cohort, hospitalization did not appear to be associated with a reduction in serious adverse events or mortality at 30 days post-ED visit. Shifting care from the inpatient to the outpatient setting for this cohort may be a more sensible approach to ED syncope care for patients who are not otherwise at high risk. Future randomized trials evaluating these alternative clinical management strategies are needed to confirm our findings.

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